Developing Numeracy in Job Corps Students: Understanding Student Thinking

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"There are a lot of well-trained curriculum experts and others who know a great deal about math, but … what is missing from their work is insight into the minds of the young people they are trying to reach" (Robert Moses, Radical Equations: Math Literacy and Civil Rights p. 102)

Numeracy

- *The ability to think about numbers in flexible ways (Conceptual)* –This means being able to "picture" a number or group of numbers and understanding how to use this information in mental calculations (this includes understanding the effect of operations on numbers).
- *The ability to judge the reasonableness of answers (Conceptual)*– Individuals with number sense are able to determine if a given answer is reasonable.
- *An understanding of the relative size and magnitude of numbers (Conceptual)* – Number sense in this regard refers to an individual's ability to draw upon information they already know to determine the value of a number or quantity.
- *Flexibility in working with the notations that are associated with numbers and their operations (Procedural)* -Students must be able to move flexibly between fractions, decimals and percents and carry out the operations associated with numbers including whole numbers and integers.

Thinking about numbers in flexible ways

- 3/7, 3/5, 7/8, 14/13
- AM: O.K., you put three-fifths, three-sevenths, seven-eighths and fourteen-thirteenths. Why did you put them in that order? (3/5, 3/7, 7/8, 14/13)
- EJ: Because……the five is smaller than any of these and the three is smaller than these two down here and this is smaller than these two and this is smaller than that.
- AM: O.K., but you have a three here on top. How did you decide which goes where?
- EJ: Because the five is smaller than the seven.

- ***AM:*** Tony, I'm going to give you four cards and I want you put them order from smallest to largest, o.k.? From least to greatest. I want you to line them up, the smallest here and the largest here. Once you do that, I'm going to ask you to put them on a number line. O.K.? You're going to write where they go on this number line, but before you do that, can you put them in order from smallest to largest?
- ***TD:*** A lot of numbers!
- ***AM:*** Tell me what you are thinking.
- ***TD:*** Huh??
- ***AM:*** Tell me what you are thinking.
- ***TD:*** Seeing if dividing it will work.

- ***AM:*** O.K. So I see you just did three divided by five.
- ***TD:*** I don't know how to do it. How can you like add a remainder when you have a decimal?
- ***AM:*** You tell me. How do you do that? When you have a remainder?
- ***TD:*** Like four…like part four…hold up. So…… (working on paper)
- ***AM:*** You did thirteen divided by fourteen.
- ***TD:*** …(working on paper – talking to self)…Excuse me you said smallest?
- ***AM:*** Uh-huh. Smallest here and largest here.
- ***TD:*** Oh….it can't be……
- ***AM:*** What are you thinking about?

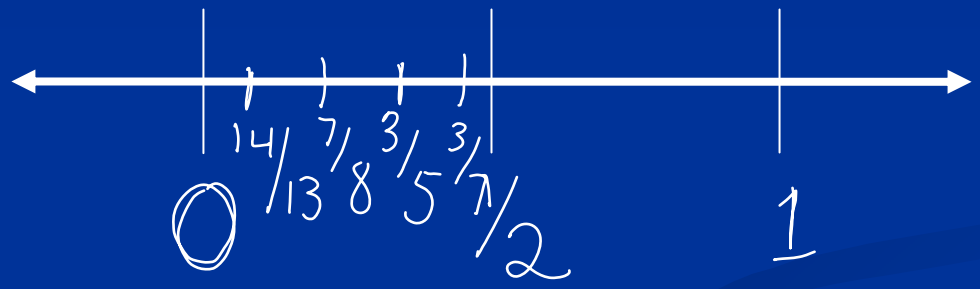
- ***TD:*** Because, usually the bigger number would be the lowest
- ***AM:*** You think what now?
- ***TD:*** Usually the bigger number would be the lowest.
- ***AM:*** What do you mean?
- ***TD:*** I can't explain it…like think of a pie like that like three-fifths would be bigger than fourteen –thirteenths.
- ***AM:*** Why?

- ***TD:*** Because three-fifths of a pie is more of than this, like you get fourteen over thirteen of a pie would be like small pieces….
- ***AM:*** The pieces are really small, so what you are saying is that the smaller pieces that's a smaller fraction
- ***TD:*** Yeah, the larger piece……I mean the larger than that……I can't explain it.
- ***AM:*** So you don't know where to put the fourteen-thirteenths?
- ***TD:*** Yeah, I know where….I think it goes….hold up…
- ***AM:*** O.K., so you have three-sevenths, three fifths, seven eighths and fourteen thirteenths.

- ***AM:*** O.K…..., turn your paper over and write those numbers on that first number line. Where do you think they go on the number line?
- ***TD:*** Which one?
- ***AM:*** Right here. This number line.
- ***TD:*** Oh, this one?
- ***AM:*** Uh-huh.
- ***TD:*** I don't know how to use this….I just don't know!
- ***AM:*** Just where do you think they go?
- ***TD:*** I think right here.

The Number Line

Tyree's Number Line:



- AM: So, if I ask you to put those on this number line, where would they go on the number line? Can you write them on this number line for me?
- IA: ……..(very long pause, student seems confused) ……
- AM: What are you thinking?
- IA: I'm trying to think how I like, I start from the biggest number because of the way this is going and I have to know how the little rubric (?) thing go like you gotta know like one-third stuff like that.
- AM: O.K…….
- IA: …..I forgot how you……I forgot how you do this….um…… …….
- ……(very long pause again student seems very confused by number line)
  ……

- AM: Can you tell me what you are doing?
- IA: I was trying to count because mainly through the fractions it's like one-tenth like the smallest one is like one tenth so I was trying to count up to one-tenth and then I do another one-tenth that would be like two-tenths and then three-tenths, because I never really got into this kind of math
- AM: O.K……..Can those numbers help you at all? Can the zeros and the one half and the one?
- IA: Yeah…..but I forgot…..because I never really got to really know this so I don't really know. It was never really was explained to me.
- AM: Oh, o.k. So do you think that that's too difficult to do…….because it's o.k., if you really never saw that and you don't know how to do it, I don't want you to have to sit there and have to try to figure it all out.
- IA: Uh-huh.

- ***AM:*** O.K., Can you put those on the number line for me? Where do you think they would go on the number line?
- ***CW:*** It doesn't go far enough.
- ***AM:*** You can extend it if you need to
- ***CW:*** Talking to self. This is not going to be able to go far enough because it has to go to fourteen…'cause these are the whole numbers, zero, half, whole and then half, whole…
- ***AM:*** Oh…..O.K., so if you need to re-number, then re-number that number line so it will work for you.
- ***CW:*** O.K., ……..no…..no……that's not it!

- ***AM:*** O.K., did you put it on the number line?
- ***CW:*** No.
- ***AM:*** What are you doing?
- ***CW:*** I don't know…….but I know that it doesn't need to be extended.
- ***AM:*** O.K., …..Why is it giving you trouble? What's giving you trouble?
- ***CW:*** I'm trying to figure out …see it only goes up to one and a half. These are just fractions so maybe I need to change the form. This is eight wholes and seven of eight……I don't know how to do this. Think, think, think, think, think……I think maybe I should change this. No I still don't know how to do it.
- ***AM:*** Do you want to go on to the next problem?
- ***CW:*** Uh-huh.

Engaging in "Math Talk"

- Students with a weak understanding of math find it difficult to use vocabulary in meaningful ways
- Students with a weak understanding of math have not connected printed representations to verbal representations of math which impacts understanding

What can Job Corps do?

- Current practices should be designed to develop conceptual understanding in students
  - Emphasis on worksheet completion does not assist in the development of numeracy in students who enter the program with a weak foundation in math.
- Encourage "math talk" in math classrooms.
  - Research has shown that the more students engage in discussion about math, the more they understand critical concepts that help build numeracy.